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THE MIAMI CONSERVANCY BULLETIN

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FIG. 228—TOPPING OUT THE GERMANTOWN DAM, NOVEMBER 3, 1920

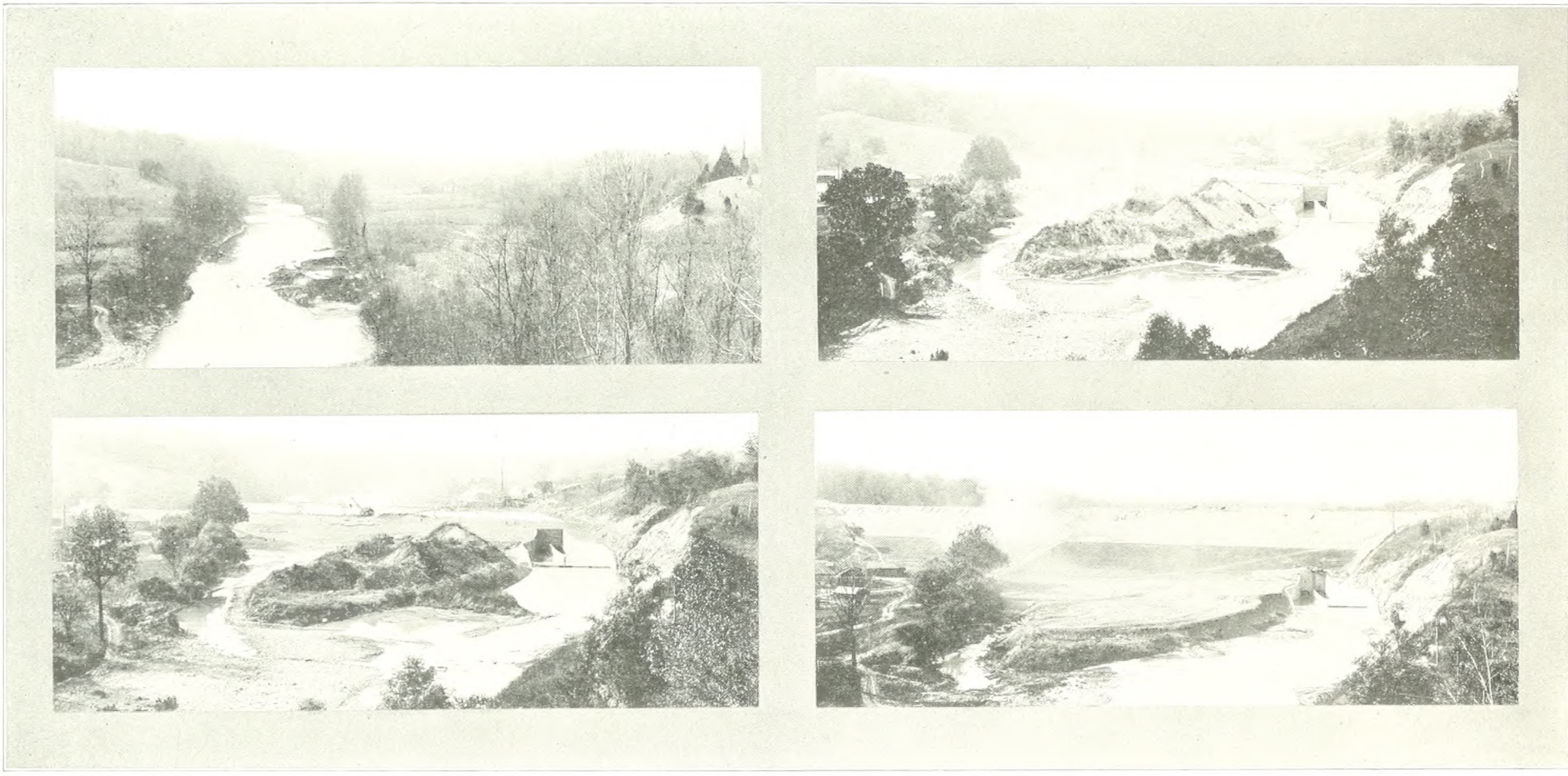

FIG. 229—PROGRESS PICTURES OF THE GERMANTOWN DAM CONSTRUCTION

These views were all taken from the same point, looking westerly up the Twin Creek valley. The upper left shows the conditions bfore any work was done, on March 20, 1918. The upper right shows the progress to August 6, 1919. Part of the camp can be seen at the left on the right bank of the old creek bed, over which can be seen the cable suspension bridge still in use, although the water of the stream is now flowing through the conduits. The conduit outlets appear at the right, the conduits being complete in their temporary form, giving double capacity of flow to prevent possible flood overtopping the unfinished dam during construction. Above and to the left of the conduits appears the core pool, occupying the top of the low dam embankment, the building of the latter having been started on June 30 preceding. The pool occupies as yet only the part of the valley floor north of the stream bed, being separated from the latter by a low cross dam thrown up by a dragline excavator.

At the lower left the conditions are shown as they were on October 20 following. The core pool and dam embankment now extend across the entire valley, effecting "closure." The dredge pump station can be seen at the right above the pool, with its tall derrick mast for handling machinery in and out of the "hogbox" and pump house. The earth materials composing the dam embankment are brought to this point from the valley floor above by dump car trains, and pumped thence, mixed with water, to the pool on the dam. The dragline excavator on the dam embankment is building up the retaining levees of the pool.

The lower right picture shows the completed dam embankment, 110 feet high above the old stream bed.

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THE
MIAMI CONSERVANCY BULLETIN
PUBLISHED BY THE MIAMI CONSERVANCY DISTRICT
DAYTON, OHIO

Volume 3 | December 1920 | Number 5

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Subscription to the Bulletin is 50 cents per year. At news stands 5 cents per copy. **Business letters should be sent to Office Engineer, Miami Conservancy District, Dayton, Ohio. Matter for publication should be sent to Bulletin Office, Miami Conservancy District, Dayton, Ohio.**

G. L. TEEPLE, Assistant Engineer, EDITOR.

A Germantown Bulletin

The present number of the Bulletin, as will be noted, is devoted to various aspects of the work at the Germantown dam connected with the finishing features of the construction, or suggested by them. To properly present these it has been necessary to encroach on our usual editorial space, and to crowd out a number of interesting matters. The dam embankment is complete, except for the surfacing of the upper part of the slopes. The conduits are complete, or will be by the end of the month and year. The cleaning and trimming, the disposal of the construction camp and the dismantling of the working plant still remain (although the last item is well advanced). For practical purposes, therefore, the Germantown dam is finished. Any future flood coming down Twin Creek valley to swell the rising waters of the Miami, will find in its path a wall solid as the enclosing hills on each side, and as high, rising 110 feet above the old stream bed. Only through the outlet conduits, built of solid concrete locked into the bed rock, will the waters be able to find their way. At the lower end of the conduits they will emerge—robbed of their destructive energy in the "hydraulic jump pool," created by the engineers to receive and quench it—and pass on harmlessly down the valley.

It is worth while to pause at this so significant stage of the flood prevention project, and consider what it means. After all the doubts and fears, after the months and years of study and preparation and after nearly three years more devoted to the actual work of construction, that which was only dream and desire has become a fact. The first of the Conservancy dams stands completed. And it has not only become a fact, but it has become a tried fact. It has been through a flood—a very considerable flood—that of April of the present year—and it stood the test. The embankment, the conduits and the conduit outlet works, all performed their function. They performed it according to design. No weakness developed. Nothing had to be revised. The work of construction went on to completion—successful completion. The work of the hydraulic fill especially, it is to be noted, which was the object of doubt and criticism on the part of some, was carried on without developing a sign of failure or weakness. There has been neither undue settlement, nor slippage, nor breakage, in the dam embankment as it rose to completion, nor any sign of these such as might cause worry or fear. The Germantown dam stands completed, and in such manner that it will continue to stand, for centuries, for all time that men may need it, between the people of the Miami Valley below, and the threatenings of flood.

It is worth while, we repeat, to pause and consider these things. They are just cause, we think, for especial satisfaction, to the originators of the project, to its directors, to the engineers who designed and supervised the work, to the workers who carried it out, to the people of the Miami Valley—to the people of Middletown and Hamilton especially, who can all feel in what has been done not only satisfaction for the past performance, but an augury for the future, when the entire project shall stand, as Germantown now stands, in full completion.

Finishing the Germantown Conduits

The North Conduit, the First to be Completed on the Conservancy Project, Finished November 27, 1920.

It has been heretofore noted that the conduits which carry the streams under the Conservancy dams are so designed as to give them during the period of construction a capacity much greater than normal. The object of this is to preclude the danger of a flood overtopping the partly completed embankment. To insure this, the conduits are given temporarily an excessive depth, permitting a stream flow about double the final figure.

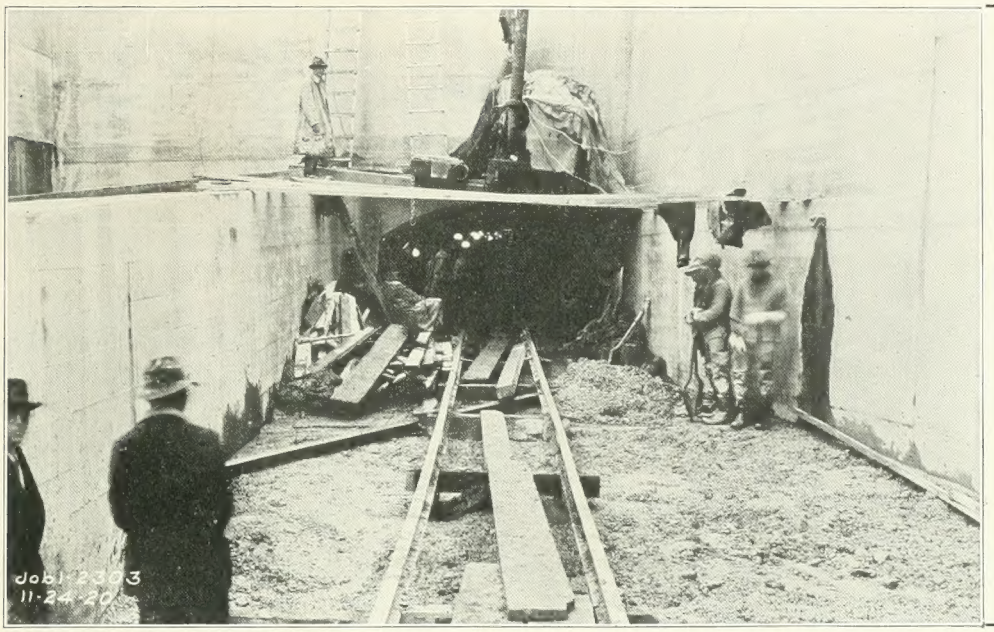
The Germantown dam embankment, as noted elsewhere, having now been completed to its full elevation, this special temporary feature is no longer necessary. The north conduit has already been given its final form, and work is now in progress on the other. Fig. 230 shows the north conduit just completed and undergoing inspection by the officials of the District a few moments before the water of Twin Creek was finally turned into it.

The work of this final stage of the conduit construction brings vividly into view the reason for providing two (or more) conduits at each of the Conservancy dams. The valley being entirely blocked by the dam embankment, one conduit must carry the creek water while the other is being given its final form; the stream must then be turned into the completed conduit and the process repeated on the second one, the mouths of each opening in turn being blocked against the creek water, to keep the conduit dry while the work is being done upon it.

Provision had been made for these coffer dams in building the entrance channel walls, vertical grooves having been cast in the concrete of the two side walls and the center partition wall, opposite each other, to receive the ends of timbers to be laid horizontally across the entrance. Four such timbers were used, 8″ by 16″, spaced closer together toward the bottom because the water pressure, whose total force these timbers must resist, is greatest there. Vertical planks were then set up against these timbers, and the planks faced with vertical matched flooring to close the cracks, a few subsequent leaks being calked with oakum, and the flooring being chisel edged and driven till it "broomed" against the conduit bottom to shut off any leaks there. At the exit end of the conduit bags of mixed earth and gravel were laid about 3½ feet deep along the top of the wall or "weir" at the lower end of the pool chamber, making the wall also into a "coffer dam."

FIG. 230—CONSERVANCY OFFICIALS INSPECTING THE COMPLETED OUTLET CONDUIT AT GERMANTOWN, NOVEMBER 29, 1920.

This is the first conduit to be completed on the Conservancy project. The officers are as follows, beginning at the left: Arthur E. Morgan, Chief Engineer; Ezra M. Kuhns, Secretary, Board of Directors; E. A. Deeds, President, Board of Directors; Arthur H. Pauls, Division Engineer, Germantown Dam; Albert Armstrong, Superintendent, Germantown Dam; Chas. H. Paul, Assistant Chief Engineer; Oren Britt Brown, Attorney for the District; Henry M. Allen, Board of Directors; Gordon S. Rentschler, Board of Directors; C. H Locher, Construction Manager. For description of conduit, see pages 68 and 69.



The conduits were originally built with a height to give them ample capacity to carry flood water during the work of construction, and thus prevent flood overtopping the unfinished dam embankment during the work of construction. After the embankment was completed, the lower part of the conduit was filled with sand and gravel, over which was laid a floor of concrete averaging about three feet thick. The narrow gage railway track in the picture carries a little car and gasoline locomotive which bring the concrete from the mixer at the other end of the conduit.

FIG. 231—FINISHING THE CONDUIT FLOOR, GERMANTOWN DAM, NOVEMBER 24, 1920

This made the conduit into a great tank or cistern, about 700 feet long and ten feet wide, with about twelve feet of water in it. It held in fact about 700,000 gallons, and was pumped dry by a six-inch "centrifugal pump," harnessed to an electric motor, in about 12 hours. (A little less than a thousand gallons a minute.)

The lower half of the conduit was now ready to be filled in. The material used for most of this was sand and gravel, the lower part of the fill being of these materials, topped with the final floor of the conduit, which is of concrete. The conduit floor has no very great pressure to withstand except at the entrance Hence it need not be thick, and the sand and gravel deposited below it are amply solid to support whatever slight pressure the floor slab transmits to them. The floor slab, in fact, is arched below, although flat above, and is really supported by the massive side walls of the conduit. Its shape is shown in Fig. 232, which is a section of the Englewood conduits (almost a replica of those at Germantown). The floor slab occupies the space between the two dotted lines crossing the left conduit; the sand and gravel occupy the space below; the space above shows the final conduit opening.

At the entrance, however, provision for the heavy possible pressures when the water backs up behind the dam under flood is very important, and to meet them a solid concrete "bulkhead" was built ten feet thick, filling the entire space between the permanent floor and the solid bedrock beneath, notching into the latter and into the walls on each side. The main function of this bulkhead is to act as a "plug" for the tunnel occupied by the sand and gravel, protecting it from the powerful thrust of the flood water, which if it got in would be likely to break up through the conduit floor. The conduit is indeed full of water, which might be expected to balance this thrust, but in fact conduit water at such times is rushing toward the outlet at high velocity, up to over 50 feet a second at maximum flood, and the powerful pressure at the entrance has been lost in giving it this high speed. (Just as the force in a halfback's foot vanishes in the drive of the football toward the goal.)

In the open roofed chamber just in front of the conduit entrance, this plug or bulkhead is again replaced by gravel and sand, to which water is admitted by holes purposely cast in the concrete floor, thus equalizing the pressure above and below the latter, by the well known law that in water the pressure in every direction is the same.

A similar but much shorter bulkhead (5 feet long), was put in under the conduit exit, more as a reinforcement to the opening than to act as a plug, since the heavy pressures noted do not appear here.

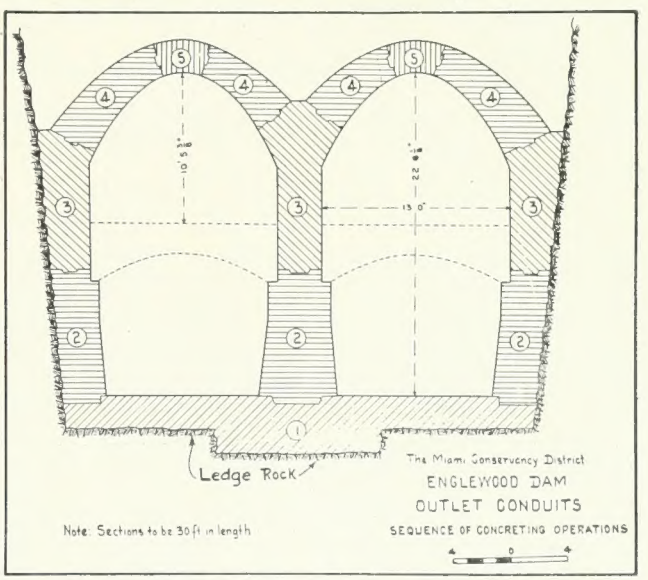


FIG. 232—CROSS SECTION OF CONDUITS

Shows the temporary section, giving approximately double height and double carrying capacity. They are brought to the final shape by filling the lower half, below the curved dotted line, with sand and gravel. This material is then floored over with concrete to the horizontal dotted line. This floor is 4 feet thick at the sides and 2 feet thick at the center. See page 69.

The gravel was washed and screened at the time the conduits were built in their temporary form, and stored in these stock piles until needed in order to permit the gravel plant to be taken to Dayton for work there. The small dragline excavator travels along the bank from pile to pile, loading the several sizes as they are needed. The narrow gage cars and little gasoline locomotive take the materials to the concrete mixer at the mouth of the conduit, where they are dumped into

(Continued below)

FIG. 233—LOADING CARS WITH CONCRETE "AGGREGATE," NOVEMBER 24, 1920.

hopper bins from which they are "chuted" into the concrete mixer through measuring boxes to secure the correct proportions.

The sand and gravel filling, which followed the building of the plugs, was transported and placed in a manner similar to the filling up of the "ditch" on the dam shown in Fig. 228, the dredge pipe line being carried down the center of the conduit, and the material being pumped through it as in ordinary hydraulic fill.

The last step, the placing of the concrete floor, is shown in its main features in Fig. 230, heretofore referred to, and in Fig. 231, which shows the conduit exit finished, with the track which carried the little gasoline locomotive and rocking hopper car by which the concrete was transported and dumped. The rails for the track were laid on blocks on the deposited gravel fill. This filling was given an arch shape on its upper surface, and the mixed concrete deposited on this surface and leveled on top to correspond with the shape shown in Fig. 232. The depth of the concrete was two feet at the center of its width, and four feet at its edges; the top foot being a "rich mix," similar to that used in the conduit arches. The gravel for the concrete was washed and screened into sizes at the time the main work on the conduits was done (to permit the gravel washer to be dismantled for other work in Dayton), and the materials stored in stock piles until wanted. Fig. 233 shows a small dragline excavator loading the gravel from these piles into small cars drawn by another gasoline locomotive to the bins, whence it was chuted through measuring boxes to the mixer below as wanted.

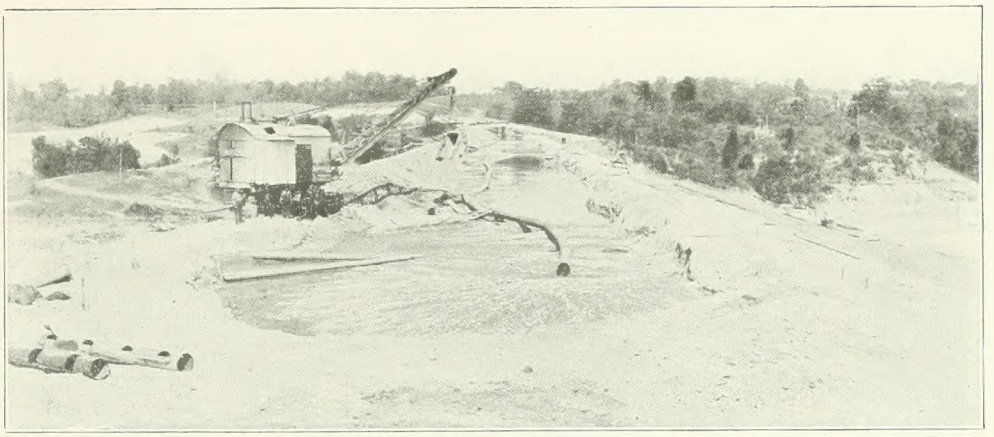
Topping Out the Germantown Dam Embankment

A Mixture of All Borrow Pit Materials, Deposited Together in a Narrow Center Pool by the Hydraulic Method, Builds the Upper Layers.

A hydraulic fill dam consists essentially of a central impervious core "sandwiched in" between two sand and gravel embankments which provide drainage for the core during construction and give the dam stability. The core is deposited as clay mud on the bottom of the core pool which is carried at the summit of the growing dam embankment, along its center line. The sand and gravel are deposited on the sloping beaches of the pool by the water as it flows down these slopes from the dredge pipes which bring the mixed earth and water from the pumps. Between the true core and the enclosing sand and gravel embankments there is a "transition zone" of mingled sand, gravel and mud, of variable thickness according to circumstances.

All of these features have been described in earlier issues of the Bulletin (see especially page 105 of the Bulletin for February, 1920), and are shown in the cross section of the Germantown dam exhibited in Fig. 235 of the present issue. In this figure P represents the pool, BB the beaches, LL the levees, and DD the dredge pipes bringing the water and suspended solids, at the stage when the dam had been built up to about elevation 815, 15 feet below the dam crest. The transition zone is marked as such.

The actual appearance of the dam at about this stage is shown in Fig. 234, taken from the south end of the dam, looking northward along its center line, October 13, 1920. This is a late stage in the dam building (15 feet from the top in a total height of about 106 feet). The pool by this time is so narrow, therefore (about fifteen feet in width) that the transition zone unavoidably encroaches on the true core zone, as is evident from the mixed clay and gravel in the nearest part of the pool. But the pool surface at this stage being about at the level of the assumed maximum flood in Twin Creek Valley, (spillway level) the encroachment is not harmful, the mixture of coarser materials with the clay producing a "mud concrete" which is practically impervious under the low head of water which it will ever be called upon to resist.



This was begun at an elevation about 15 feet below the dam summit. The dragline excavator seen scooped the materials out of the bottom of the core pool and used them to build up the side levees, giving the section shown by the line AAA in Fig. 235. The main object of this deep digging out was to break up possible sand and gravel strata which might build out from the two beaches of the pool and permit leakage.

FIG. 234—FIRST STAGE OF TOPPING OUT THE GERMANTOWN DAM. OCTOBER 13, 1920.

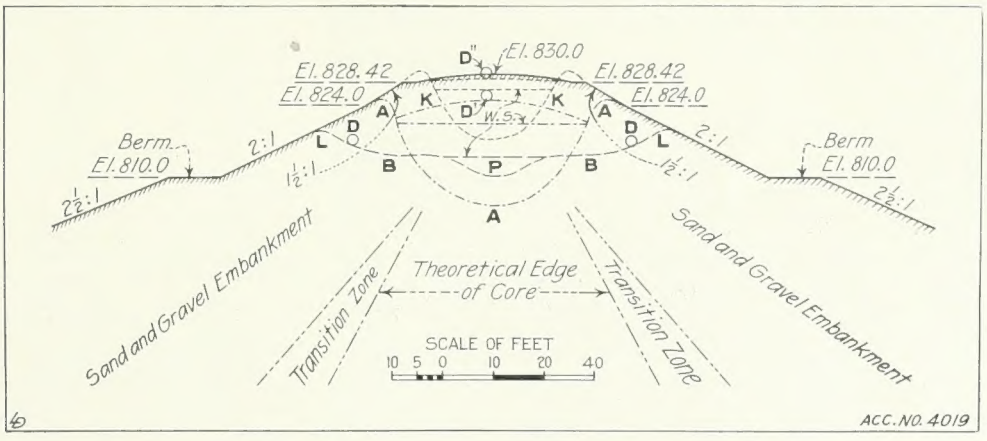
In fact, in the upper layers of the dam embankment, at the elevation shown in the picture and above, the deposition of a true core is abandoned as unnecessary, and "mud concrete" is substituted. This has the advantage of providing also an immediate solid foundation for the roadway which is to be carried along the summit of the dam, connecting the roads on the north and south sides of Twin Creek Valley. This is the more desirable, inasmuch as the upper layers of mud, many feet in thickness, as deposited in the bottom of the core pool, are quite soft, and remain so for a considerable period.

The first stage, preparatory to the changed procedure, was to excavate the bottom of the core pool to a considerable depth along the entire length of the dam. The small dragline excavator seen in Fig. 234 is engaged in this operation, the materials "fished out" of the pool bottom being used to build up the two levees topping the side slopes of the dam. The levees at Germantown were thus carried approximately to elevation 825, about 5 feet from the final dam summit, the pool bottom being lowered to about the depth indicated by the line AAA in Fig. 235. The object here was not so much to deposit the impervious mud concrete in the levees, as to mix the materials in the pool bottom, and break up any possible strata of pervious sand and gravel which might extend across the core, due to its narrowness at this elevation, and thus permit possible leakage through the dam.

Deposition of the mud concrete in the pool was then started, the materials being the same as those used to build the lower layers of the dam, and being pumped through a dredge pipe line in a similar manner, but with the use of one pipe line only. This pipe was carried nearly down the center line of the dam, discharging into one end of the pool, filling it up with the mud concrete to about the level of the line KK. The position of the dredge pipe during this process is indicated by the small circle D′.

The small dragline excavator followed the working dredge pipe along the dam embankment, digging out the central portion of the just deposited material, and casting it up on the two levees as before, carrying them thus to an elevation about two feet above the ultimate dam summit. It dug in fact, a ditch, shown in Fig. 236, of which the two levees formed the upper sides, the object of this ditch being to retain the pool on the narrow summit of the dam for the deposition by the hydraulic process of the final batch of mud concrete necessary to top out the dam.

This final operation is shown in Fig. 228, the direction of view being the same as in Fig. 236. The working dredge pipe is seen just to the left of and below the small dragline, discharging into the "ditch" just mentioned, filling it up with the mixed sand, clay and gravel. The dragline excavator follows just behind it, scooping out with its bucket such material as is necessary, and depositing it in



LL are the levees; BB the beaches; P the pool at the stage when the embankment reached an elevation 15 feet below the top. The pool bottom was then scooped out and built into the levees, giving the section AAA. Hydraulic fill was then deposited to the line KK. A repitition of these operations brought the dam to its final elevation.

FIG. 235—SECTION THROUGH UPPER PART OF GERMANTOWN DAM EMBANKMENT

Following the first stage shown in Fig. 234, the pool was nearly filled up with the earth materials brought by the dredge pipe. It was then dug out down the center line again, by the dragline excavator, creating the deep trench seen in the picture, the excavated materials being used to build up the sides of the trench still higher. This trench is then filled up as after the first stage, the dragline excavator following along just behind the discharge of the dredge pipe, and bringing the new surface to proper level by picking up with its bucket material from the pool, and depositing it where needed.

FIG. 236—RESULT OF THIRD STAGE OF TOPPING OUT GERMANTOWN DAM. NOVEMBER 3, 1920

front of and behind the machine, wherever needed to bring the dam embankment to the proper level.

The result is shown in Fig. 237, which is taken from a position just behind the dragline, and looking in the same direction as in Fig. 228. The tops of the two levees built by the dragline in its preceding operation are seen at the sides projecting above the general level, these portions being thus built a little high to provide material for the final hand finishing of the dam crest and upper slopes to the proper section, as indicated by the top full line of the drawing in Fig. 235. The dotted line in this figure indicates the top of the material deposited by the dredge pipe, the position of the latter being indicated by the small circle D".

The surface shown in Fig. 237, it will be clear, is the unfinished subgrade of the highway to be built along the crest of the dam, referred to above. It may perhaps give reassurance to some who have had certain misgivings as regards the application of the method of hydraulic fill to the construction of the Conservancy dams, to observe in Fig. 228 the 40-ton dragline excavator (a No. 36 Marion machine) traveling along the surface of the dam summit and of the proposed highway, directly above the hydraulic fill core material which occupies the embankment interior below. Under this heavy mass the material showed no signs whatever of weakness or settlement. Levels taken on the finishing stakes on the dam summit two weeks after the completion of the embankment showed also no measurable settlement during this period.

This shows the result of the operation seen in the front cover picture, Fig. 228. The dredge pipe which brings the materials to the dam summit from the pump and hogbox in the valley below, is seen on the dam center line. The view is in the same direction as in Fig. 228, but behind the dragline excavator there seen. The ridges of sand and gravel at the edges are excess material to be used in the final bringing of the dam crest to exact grade. The dam crest, 25 feet wide, will be used as a highway connecting the roads on the north and south sides of the valley.

FIG. 237—GERMANTOWN DAM SUMMIT AFTER LAST DEPOSIT OF MATERIALS. NOV. 3, 1920

October Progress on the Work

GERMANTOWN

The last of the hydraulic embankment was placed November 6, 1920. During the month of October and first six days of November 44,724 cubic yards of hydraulic embankment were pumped in place, completing the hydraulic embankment of the dam with a total of 795,907 cubic yards of material placed.

This month also marks the completion of the spillway bridge. All false work is removed and all trimming and finishing of rough concrete completed.

The north conduit has been closed and the creek flow is now being carried by the south conduit. Gravel has been pumped into the north conduit. The plugs at the inlet and outlet ends of the conduit are concrete; also the floor in the inlet entrance and in section 1, 3, 5, 6, 7, 8, 9, 10, 11, 13, 15 and 17 of the conduit.

Mr. Conley is graveling Road No. 1 between the State Road and the dam, this portion being under contract; also that portion of Road No. 1 between the dam and the spillway, this section being done by day rate.

Dismantling of equipment is under way. So far the dredge pipe line on the dam, the 15-inch booster dredge pump, the 8-inch primary monitor pump, the 8-inch booster monitor pump and all pipe line in the sluice borrow pit have been removed.

A. L. Pauls, Division Engineer.

November 23, 1920.

ENGLEWOOD

The hydraulic fill for October shows a decrease in the monthly rate of progress, due to the fact that pumping operations were suspended for a week incidental to including in the fill that portion of the dam which had been run the preceding year. From May 6 to October 11 pumping operations were confined exclusively to building that portion of the dam occupying the old river bed. Early in October, however, the river closure had reached the elevation of the section formerly placed and steps were taken to run the two sections as a unit. During the month, ending October 25, 108,000 cubic yards of hydraulic fill were placed. During this time also 1,200 cubic yards of rolled fill were estimated. The total embankment on estimate date was 2,041,000 cubic yards, or 57 per cent of the finished dam.

The large electric dragline, formerly working on Cross Dam No. 2, moved into position and began excavating for the temporary spillway, digging cut-off trench as it progressed.

Work was continued on the crib for protecting the spur levee at the outlet of the temporary spillway.

H. S. R. McCurdy, Division Engineer.

November 15, 1920.

LOCKINGTON

During the last six weeks an average of 11,083 cubic yards of earth have been pumped into the dam embankment. The rate, however, is dropping, due to the approach of the freezing weather. There are about 200,000 cubic yards still required to complete this part of the work.

Heffner & Son, the contractors making the fill on Road 9, have suspended work till the ground freezes, due to the muddy condition of the material being moved. Some progress is being made on Road 11.

The telephone line of the Tidewater Pipe Co. is being rebuilt along the relocation, taking it out of the Lockington retarding basin.

Barton M. Jones, Division Engineer.

November 25, 1920.

TAYLORSVILLE

The work on the inlet channel has been slowed down considerably during the last month, due to the fact that as the channel has neared completion the dumping space for the dragline has become very limited, so much so that for the last two weeks the night shift has been taken off. About December 1, the giants will be moved back to the borrow pit in the hill, and the dragline will cast the little that remains in the inlet channel over into the toe of the dam to the west.

The concrete paving on the upstream toe of the dam near the inlet channel has been finished and the Bucyrus dragline has been moved down to excavate for the paving on the lower toe of the dam adjoining the west edge of the outlet channel. A part of this paving is now being placed and all of that part below ordinary water level will be finished in a few days, so that the river can be turned into the concrete works from the inlet channel as soon as the Lidgerwood dragline finishes its work at this point.

Mr. Crampton has finished all the grading on Road 12 except a few of the ditches and culverts.

O. N. Floyd, Division Engineer.

November 25, 1920.

HUFFMAN

The upstream slope of the dam has been built up to elevation 806, in that part of the dam across the diversion channel. The gap across the old Erie Railroad and the old Valley Pike has also been built up to this same elevation. The upstream slope of the main part of the dam is at elevation 810.

47,000 cubic yards of material were placed in the dam during the month of October. The day shift was engaged in railroad work until the 18th. No more material can be placed in the main part of the dam until the closure of the gap at the old Erie Railroad has been entirely completed, which will allow the raising of the water in the center pool. For this reason the sluicing plant on the hill at the north end of the dam has been idle during the past month.

That part of the oversize rock rejected by the revolving screen at the pumping plant, smaller than 15 inches in diameter, is being placed as paving on the upstream slope of the dam. About 400 lineal feet of the dam have been covered with this rock up to the first berm. The boulders over 15 inches are being placed as rip-rap on the north slope of the entrance channel to the outlet works.

C. C. Chambers, Division Engineer.

November 20, 1920.

DAYTON

Channel excavation has been continued during the past month by dragline D-15, placing the material into levee and spoil bank fill along the right bank above Stewart Street. This machine will make the excavation for a new 16-inch water main to be laid across the river above Stewart Street bridge before crossing to the south side of Stewart Street. D-16 is working upstream between Third and Fifth Streets. D-8 has continued to unload material from scows at the gravel plant. D-19 performed the necessary excavation for lowering the 10-inch cast iron sewer pipe crossing under the river between Floral Avenue and Wilkinson Street and is now cleaning up the levee and channel slopes along the right bank below Main Street.

Favorable progress is being made on river wall work. Stillwater Drive wall is 89 per cent complete, 3,320 cubic yards of concrete having been placed. Beach Avenue wall is 26 per cent complete, 860 cubic yards having been placed. In the First Street wall 315 cubic yards, or 18 per cent of the total have been placed.

Revetment on the right bank, upstream from Dayton View bridge, has been completed. Price Brothers are constructing revetment on the left bank at Herman Avenue and driving steel sheet piling to finished grade across the channel below the bridge.

An agreement has been made with J. C. McCann for doing the excavation and embankment work on Mad River.

To date 53,900 cubic yards of sand and gravel have been issued from the gravel plant.

Previous to November 1, 776,300 cubic yards of channel excavation (Item 9), had been removed and 128,500 cubic yards of levee embankment placed. The total yardage handled in accomplishing that work amounted to 1,755,600 cubic yards.

These figures do not include 105,000 cubic yards of excess excavation for the launching basin and scowing canals.

C. A. Bock, Division Engineer.

November 23, 1900.

HAMILTON

Dragline D-16-18 has started south on the west side of the river below Main Street, finishing up the levee and channel slopes.

The total amount of channel excavation, item 9, to November 1st, was 791,300 cubic yards.

At the Black Street bridge concreting of pier No. 2 has been completed up to the beginning of the arch reinforcement. The Bucyrus steam dragline D-16-17 has completed the coffer dam for piers 5 and 6 and has driven the piling for the footing of pier No. 5.

A line of steel sheet piling has been driven by Price Brothers across the river near the north end of the channel improvement. Price Brothers have also finished driving the trestle over Old River at North Third Street.

All work on the pipe lines across Old River has been completed and the Marion steam shovel dismantled for shipment. The Ford power plant has been placed in operation.

Price Brothers' concrete block plant was closed for the winter on November 13. The total number of blocks manufactured to date at Hamilton is 147,000. About 90,000 more are to be cast next year.

C. H. Eiffert, Division Engineer.

November 23, 1920.

UPPER RIVER WORK

Troy—Since the last report, the dragline working on the Jeffrey contract has completed its first trip between Market Street and the B. & O. R. R., has excavated for the deep channel under the B. & O. R. R. bridge, and is now better than half way on its second trip between the two bridges. This second trip will complete the channel excavation to be made by the dragline in this section of the work. In doing this work about 18,000 cubic yards of Item 9 has been handled.

The C. & C. Haulage Company divided its forces on October 24, bringing one shovel into the gravel cast over by the dragline below Market Street. Due to the bad weather conditions, this part of their work has progressed much better than above Market Street. The material excavated below Market Street has all been placed along the west side of North Market Street, forming the new house lots. The total yardage of the Haulage Company to date amounts to 55,000 cubic yards.

The Finke Engineering Company has placed 4,300 cubic yards in the south levee during the last month, and about 800 cubic yards in the south approach of North Harrison Street to Morgan Ditch crossing. The levee on the north side of Morgan Ditch has been completed and seeded. This leaves only 750 feet of the south levee to build, besides the raising of Harrison, Atlantic and Elm Streets. The total yardage of the Finke Company to date is 24,500 cubic yards.

The North Harrison Street bridge, over Morgan Ditch, has been raised to meet the grade of the street raising, and the additions to the abutments have been made. This work was done by District forces.

Piqua—The first indications of construction work at Piqua appeared in the form of parts of a derrick. This derrick will be set up near the freight depot of the Ohio Western R. R. at the northwest end of town and will be used to unload the dragline at the same place. The place of unloading is within one hundred feet of the beginning of the new levee, which extends along the town side of the Miami River, filling up the M. & E. Canal to a point below the North Main Street bridge. The dragline is expected to arrive in Piqua about the first of the new year.

A. F. Griffin, Assistant Engineer.

November 20, 1920.

TROY

The report for Troy will be found with that for the upper river work, under which head all reports of work at Troy will hereafter be placed.

LOWER RIVER WORK

Miamisburg—Since our last report Cole Brothers have constructed 900 linear feet of levee—about 17,000 cubic yards—extending southerly along the east bank of the river, commencing at the C. & D. Traction line a short distance south of the north corporation line.

Thomas Daniel & Son have two or three days' work for their team outfit to complete the fill for the Main Street elevation. This fill will be crowned and used as a gravel road over winter, in order to give it a chance to settle before the pavement is re-laid. However, as the material in the fill is nearly all gravel and is being constructed with a team and wagon outfit, not very much settlement is anticipated, and for the same reason not much difficulty is looked for in carrying the heavy traffic which passes over this road. Guard rail material is on the ground and will be erected as soon as the fill is completed.

Franklin—Jeffrey, Boorhem & Company have completed the dragline work on the west levee and now have a force of men dressing the top and slopes.

Work on the Chautauqua levee is progressing satisfactorily, considering the wet weather. Four or five days' work should complete the fill.

Middletown—Revetment construction was within four or five days' work of completion on November 24 and consequently no serious damage resulted from the high water which occurred on that date. When this work is done the levee south of Third Street will be complete, with the exception of a little dressing and seeding.

F. G. Blackwell, Assistant Engineer.

November 27, 1920.

The excavation cuts through the "saddle," shown in Fig. 241, and may be seen just beyond and to the left of the small steam shovel: the view here being about at right angles to that in Fig. 241. The steam shovel did the heaviest of the digging, the dirt being hauled away in dump wagons, and "wasted." The small buildings are the cement house and the hoist engine house, seen also at the left in Fig. 242, the view in which is from the same direction as here, but closer up. See also Fig. 244. The total excavation for the spillway was 18,300 cubic yards.

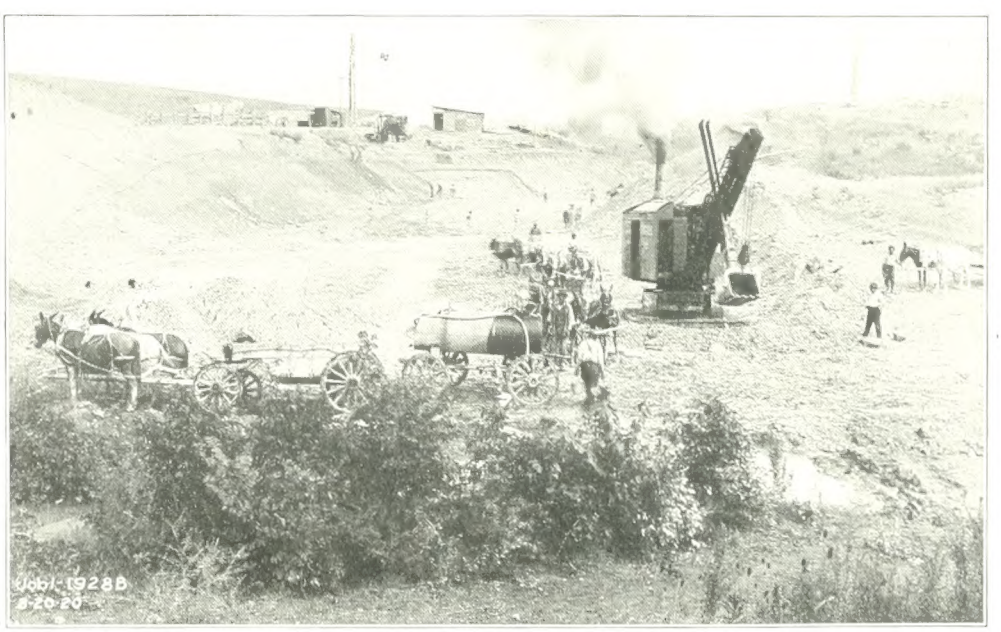


FIG. 238—EXCAVATING FOR THE GERMANTOWN SPILLWAY, AUGUST 20, 1920

RAILWAY RELOCATION

Big Four & Erie—These railroads are practically completed with the exception of the station buildings, Erie team tracks and miscellaneous items. Mr. M. K. Frank is dismantling the Erie old line and has about 30 per cent of material taken up.

Baltimore & Ohio Railroad—Mr. J. C. McCann has almost completed his contract for the grading on the Narrows. All other work has been completed.

Ohio Electric Railroad—This railroad from Huffman to Fairfield is almost complete for operation, there remaining to be done the ballasting of the passing tracks, constructing the connections at both ends and the bonding of the rails.

Albert Larsen, Division Engineer.

November 20, 1920.

RIVER AND WEATHER CONDITIONS

The month of October was comparatively dry, no rain whatever occurring during the first three weeks. The total precipitation for the month occurred during the storm beginning on the 25th and ending on the 28th, the amounts varying from 1.48 inches at the Huffman Dam to 2.73 inches at Pleasant Hill. At Dayton the total amounted to 1.61 inches or 0.79 inches less than normal, raising the accumulated deficiency since January 1 to 3.47 inches. The rivers were comparatively low during the entire month, no rises of any consequence resulting from the storm of the 25th to the 28th.

At the Dayton Weather Bureau Office, the mean temperature for the month was 60.7 degrees, or 6.6 degrees greater than normal; there were 19 clear days, 5 partly cloudy, 7 cloudy and 4 on which the precipitation amounted to 0.01 of an inch; the average wind velocity was 8.4 miles per hour, the prevailing direction being from the southwest; and the maximum wind velocity for five minutes, was 50 miles per hour from the south on the 26th.

Ivan E. Houk, District Forecaster.

December 2, 1920.

Building the Germantown Spillway

Ideal Natural Spillway Site, 800 Feet North of the Dam, Permits a Very Inexpensive Separate Concrete Structure.

The "spillway" of a dam is in the nature of a safety valve, its function being to provide a broad and ample opening through which, in flood seasons, excess waters gathering behind the structure may be carried safely away to a point in the valley below, before they have an opportunity to rise to the dam crest. In the Conservancy dams they are short, broad, open-topped channels of concrete, with flat bottoms and sloping sides, notched into the top of the dam embankment, or into the valley slope at one side, with the bottom 15 to 16 feet below the dam crest. At Lockington, Taylorsville and Huffman the spillway is notched into the top of the dam, and in these cases it is built in one concrete structure with the conduits which carry the river flow beneath. At Germantown and Englewood the spillway is a separate structure. The type chosen in each case, whether separate or combined, is that which gives the least expensive construction. (See the Bulletin for August, 1919.)

The location for the spillway at Germantown was provided by nature, and approaches almost as near to the ideal for its purpose as if the ice sheet of the Glacial Epoch, and the subsequent waters, had eroded the valley to order. The site is shown in reference to the dam in Fig. 244. Inspection of this map will show a dry run proceeding from the spillway site down the valley slope and debouching above the dam site. Its direction, rather unusual, is diagonally upstream. Just across a narrow saddle at the spillway site, another dry run proceeds down the valley slope and debouches below the dam. It only needed to cut a few feet through the saddle and line the cut with concrete, and the spillway was complete, the two dry runs furnishing the inlet and exit channels of a by-pass, through which, and over the spillway summit, the excess flood waters can find their way around the dam. The spillway floor is fifteen feet below the level of the dam crest, and as it will take a flood 40 per cent greater than that of 1913 to reach even this floor level, the chances of water ever actually passing through the spillway are exceedingly remote. To reach the crest itself, it may be said in passing, will require a flood more than twice as great as that of 1913, a contingency which is beyond all probability of occurrence.

A further fortunate circumstance was that bed rock occurred along the saddle, jutting just above the proposed spillway floor (815 above sea level), and requiring to be peeled off to a depth of only two to four feet to provide an excellent natural floor for the structure, without going to the expense of laying concrete. The latter material had been originally provided for in the plans, but showed it to be unnecessary. Two "cut-off" walls, sunk 4 feet into the rock, extending across the channel width, with their tops flush with the floor, provide level "weirs" defining and limiting the floor of the water and guarding against any possibility of undercutting the rock floor as it weathers. The sides of the spillway are cut on a slope, and lined with concrete to guard against possible wash by flood water, these slopes being partly in earth. The principal object of the "slope revetment" of concrete is to protect the earth approaches to the spillway bridge, described later. These features are shown in Fig. 239 and Fig. 240.

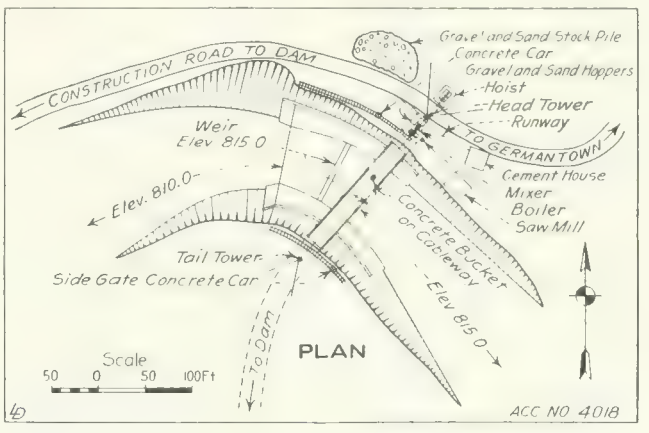


FIG. 239—PLAN OF SPILLWAY CONSTRUCTION LAYOUT

Compare Fig. 240, which shows an elevation of the same layout, and Fig. 244, which shows location relative to the dam. The sand and gravel were wheeled from the stock piles shown, and dumped into a Smith measuring hopper, and thence into the ½ cubic yard Smith concrete mixer. For the north slope revetment and cut-off wall the concrete was discharged directly to the forms through chutes, except at the west end, which was served by a small hopper car on a light railway. The south slope and cut-off wall were served similarly by a hopper car, filled by the bucket of the cableway, shown in Figs. 240 and 242.

The concrete is distributed to the bridge forms by a bucket hung from a travelling carriage running on a trolley wire (the middle wire), anchored to the two towers. The hoist engine raises and lowers the bucket and hauls the carriage back and forth as described on page 77. Timbers, concrete forms, etc., are similarly handled

FIG. 240—ELEVATION OF SPILLWAY BRIDGE CONCRETING LAYOUT AND CABLEWAY.

A point of interest to engineers is the substitution of the two flat-topped weirs referred to, for an "ogee weir" provided for originally in the plans. The ogee weir has a somewhat greater carrying capacity for water over a flat-topped weir on the ratio of 3.8 to 3.18. But would have required more concrete and more rock excavation. By widening the spillway in the same ratio, the excavation was as it were transferred from rock to earth, making the structure less expensive to build. This point also, like that referred to in the preceding paragraph, shows the care used in Conservancy designs to provide the least expensive construction which will be adequate for the purposes in view.

As is evident from Figs. 240 and 242, the spillway structure is crossed by a concrete bridge, which carries the road leading across the top of the dam, to meet the highway leading along the north side of Twin Creek valley. It was desirable to lead this road from the dam across the spillway at the level of the dam summit, so that the road may be used even if water is running over the spillway; hence the building of the bridge.

It is a concrete structure of two short "approach spans," and three 40-foot main spans, 18 feet wide between the curbs, the supporting members of each span being a center and two side beams or girders, each 6 feet deep and 20 inches wide. The floor is carried on the same level as the tops of the girders, making the bridge of the so-called "deck-girder" type, favored because it leaves no part of the main structure above the highway level, thus conducing to safety. The two central piers supporting the girders are solid, carried up from the bed rock. The end piers consist each of two broad twin posts, connected across at the top by a heavy cross beam, and with a "spread footing"—that is, a broadened rectangular base at the bottom of each post—to secure a firmer bearing below. The railings are solid, anchored to the floor by reinforcing steel. The concrete of the girders, cross beams and floor are also strengthened with heavy steel reinforcement. Cross joints in the structure are introduced at each pier, to permit temperature expansion and contraction without cracking the concrete, the ends of the girders sliding slightly on smooth steel supporting plates at the piers to facilitate the end movement. The floors are concrete slabs reinforced with steel, 9 inches thick (the width of the bridge), and 18 feet

The view is nearly north (compare plan of dam and spillway, Fig. 244). The dry run at the left leads down the valley slope and diagonally upstream, debouching just above the dam conduit entrance. The dry run at the right leads down the slope and debouches just below the conduit outlet. The saddle between needed but a few feet notched out of it to connect the two runs and provide a by-pass for the flood water should it ever rise to a point threatening to overtop the dam embankment. Bed rock provided a natural floor for this "spillway." So nearly ideal a spillway location is rare.

FIG. 241—GERMANTOWN SPILLWAY LOCATION BEFORE GROUND WAS BROKEN. APRIL 18, 1918.

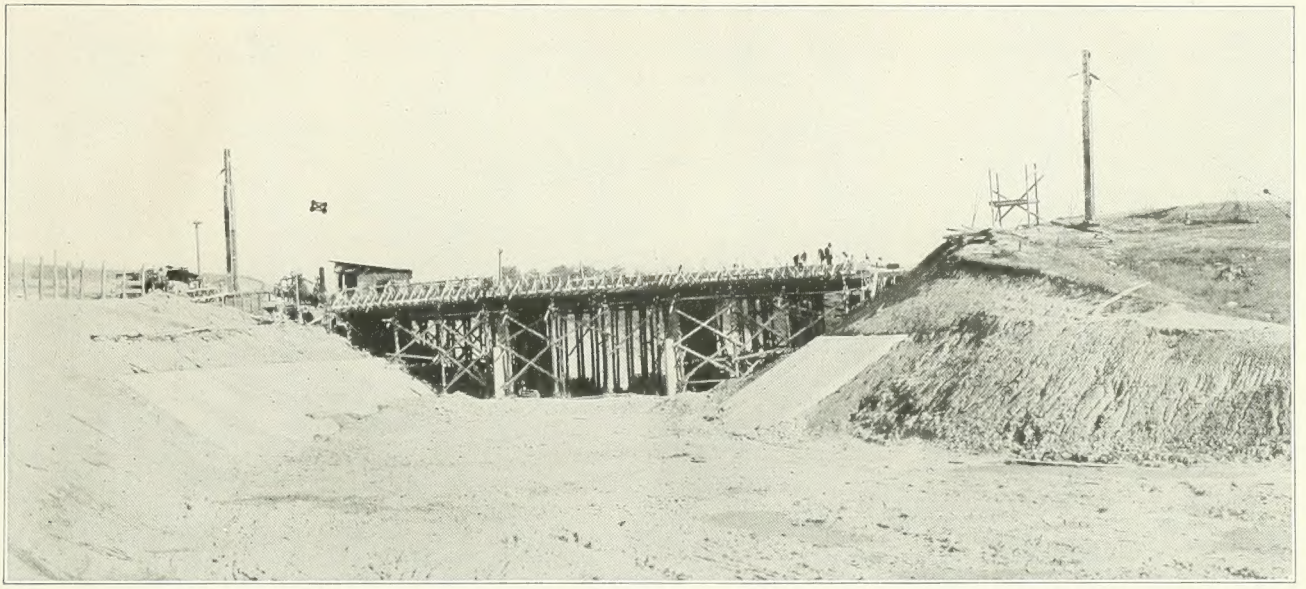


FIG. 242—BUILDING THE GERMANTOWN SPILLWAY BRIDGE, OCTOBER 13, 1920

wide, of a length to reach from pier to pier. They are cast in one piece with the three girders.

The main features of the construction of the spillway and bridge may be gathered from the plan and elevation, Figs. 239 and 240, with the aid of the pictures.

The excavation was done by wheel scrapers, or steam shovel and wagons, as best fitted the several parts of the work, and the excavated earth being "wasted" in to "spoil bank" near by. This work was done under contract by T. Daniel and Sons.

The most striking feature of the bridge construction work was the "cableway" used to convey the materials to their place. It is shown in "elevation" in Fig. 240, and in the construction picture, Fig. 242. This device is to construction work what the traveling crane is to the modern machine shop, and the trolley cash carrier is to the department store, and is especially applicable to work like that on a bridge, where the materials to be distributed lie within short distances of a long center line (at Germantown the bridge center line). A wire cable (the middle wire of Fig. 240) is stretched between two towers, one at each end of the work, and a trolley or wheeled carrier, is drawn back and forth along this wire by means of two wire ropes which wind and unwind around the "drum" of a hoist engine. A hook hangs from the carrier by another wire rope passing over the pulleys on the carrier and thence over another pulley on the "head tower" to another drum of the sand engine, enabling the hook to be raised and lowered. From the hook a concrete bucket is hung, or a chain or rope which is passed around the timbers or reinforcing steel or concrete form to be placed. Thus practically all the materials to be used in the construction can be very conveniently handled. At Huffman a "slack line cableway" was similarly used in building the arch ring bridge over the relocated railways. This required only two drum wires, the hook being raised and lowered by slacking or tautening the trolley wire itself; hence the term, "slack line cableway." At Hamilton still another variant of this device is in use on the new Black Street bridge. In each case the objective is economy in construction.

The time schedule of the bridge and spillway construction will be found in another column in this issue.

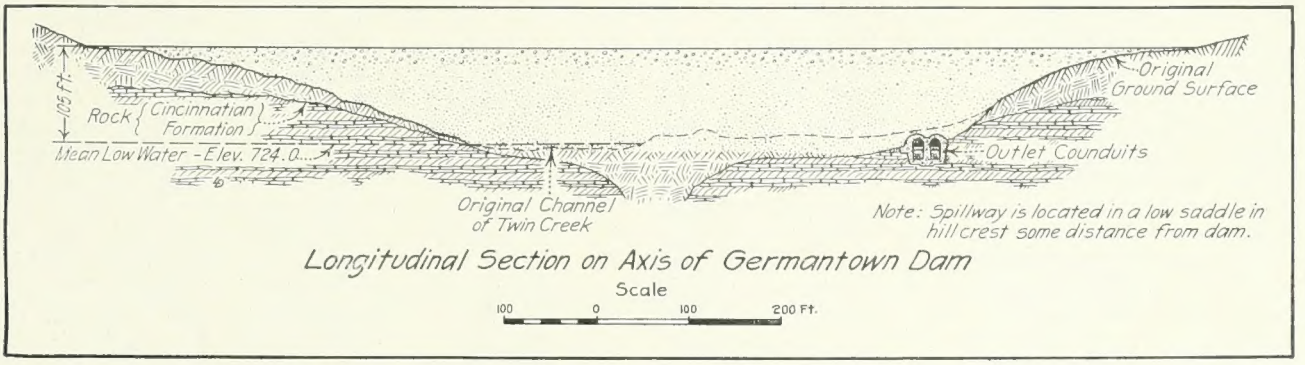

105 Ft.
Rock { Cincinnatian Formation
Mean Low Water - Elev. 724.0
Original Ground Surface
Outlet Counduits
Original Channel of Twin Creek
Note: Spillway is located in a low saddle in hill crest some distance from dam.
Longitudinal Section on Axis of Germantown Dam
Scale
100 0 100 200 Ft.

FIG. 243—LONGITUDINAL SECTION ALONG THE AXIS OF THE GERMANTOWN DAM

The dam is 1210 feet long and 110 feet above the old stream bed. Note the outlet conduits at the right, bedded in rock to the arch tops, for stability. A fence of interlocking steel sheet piling was driven to rock, or 50 feet into the subsoil, to cut off seepage beneath the dam.

Review of Construction Progress at the Germantown Dam

An Earth Dam 1,210 Feet Long and 110 Feet Above Old Stream Bed, Begun in March, 1918, and Completed in December, 1920.

The practical completion of the Germantown dam makes fitting at this time a general review of the progress of the work of construction.

The first work necessarily was the building of the camp which was to furnish the living quarters of the men. It was begun in April, 1918, and finished, practically, in June of that year, accommodating an average camp population of about 180. It included the building of 23 cottages, 12 bunkhouses, messhall, store, warehouse, first aid hospital and garage.

A sad feature of this stage of the work was the drowning of Alfred B. Mayhew, Division Engineer in charge of the dam, while directing emergency work during the flood of May 12. His place was taken by Arthur L. Pauls, then Assistant Division Engineer, under whose direction, with the assistance of Albert Armstrong, Superintendent, and C. O. Shively and W. Harnish, successive Office Engineers, the work has been carried steadily forward to a successful completion.

Along with the camp construction went forward the work of installing the plant to be used in building the concrete conduits, the latter being the first main division of the work to be undertaken. The main equipment items for this part of the work were a Lidgerwood Class K electric dragline excavator with 100 foot boom and 2½ yard bucket; a Marion Model 36 caterpillar dragline excavator with 40 foot boom and 1½ yard bucket; a Dull gravel washing and screening plant to furnish materials for the concrete, a one cubic yard Smith concrete mixer, and cars and locomotives, both standard and narrow gage, steam and gasoline, for the transportation of concrete materials and of the excavated earth. As a source of power the high tension transmission line of the Dayton Light and Power Company was extended several miles to the dam and a transformer sub-station installed.

Following the preliminary clearing and grubbing, the actual work on the conduit excavation was started by the Lidgerwood dragline on June 30, 1918, beginning at the outlet end. It was followed up, as soon as might be, by the concreting, the two processes then continuing at the same time. The pouring of the concrete began on October 5, most of the interval being accounted for by the heavy excavation required by the broad and deep outlet pools. The total conduit excavation was 105,000 cubic yards, of which about 40,000 cubic yards was rock.

The erection of the gravel washing plant began in the summer. It was completed in September, and started in at once filling its bins with the washed and screened concrete aggregates. The materials came from the gravel bed in the river bank just above the dam site, the top soil being first stripped and cast aside. The material was excellent and made a first-class quality of concrete. It was dug by the small Marion dragline excavator above referred to, and transported to the gravel washer in standard gage air dump cars drawn by saddle tank dinkie locomotives.

The conduits at Germantown are separate from the spillway structure, as noted elsewhere in this issue. They are virtually twin tunnels side by side, and as they were located next the foot of the north valley slope, it was possible to chute all the concrete by gravity into the forms from cars on a three-foot gage railway notched into the hillside. The chutes were suspended from travelling trusses spanning the conduit excavation, the trusses being carried by A-frames running on rails. The trusses were also used to shift the movable forms.

The concreting, beginning October 5, was carried on through the winter of 1918-19 with the loss of only one day, due to cold weather. This remarkably fortunate record was, of course, only made possible by the unusually mild winter. The conduits proper were finished March 17, and the conduit entrance on May 10 following, the entire work being thus finished in 7 months and 5 days. The total concrete placed was 15,368 cubic yards, a satisfactory record, considering the comparative thinness of the walls, the difficult arch forms, and the necessity for unusual care to secure the most thorough workmanship in these vital structures.

Meanwhile the large dragline excavator had dug the centerline cut-off trench for the embankment of the dam and had excavated the inlet and outlet channels connecting the conduits with the river above and below. It had also started a cross dam along the north bank of the river preparatory to building the first section of the dam embankment. This cross dam was successfully placed, using the method of "plastic fill" described in the Bulletin for February, 1920. In February, March and April also the steel sheet piling was driven in the bottom of the cut-off trench (to a maximum of 35 feet below the trench bottom). Meanwhile also the hogbox, sump and dredge pumps were being made ready for pumping the hydraulic fill into the dam embankment, this work having been begun in January.

These last preparations required until June 30, when the actual pumping began, the flow of the river having been turned through the conduits five days earlier. The north part of the embankment was started first (see the upper right picture, Fig. 229), the core pool being enclosed next the river by the cross dam along the north bank, mentioned above. To insure against seepage along the conduits the earth cast aside in excavating for them had been previously replaced as a puddle over the tops and sides of the arches. Likewise a clay blanket three feet thick had been placed, and rolled by a steam roller, over the entire area between the centerline cut-off trench and the upstream toe of the dam, to prevent seepage under the hydraulic fill. The material for the hydraulic fill was obtained by excavating the valley bottom just above the damsite with the large dragline, transportation to the hogbox being by 12-yard standard gage dump cars and steam dinkies.

It was soon found that the valley bottom material contained insufficient fines, and it was therefore supplemented by the top layers from the valley slope just north of the hogbox, opposite the up-

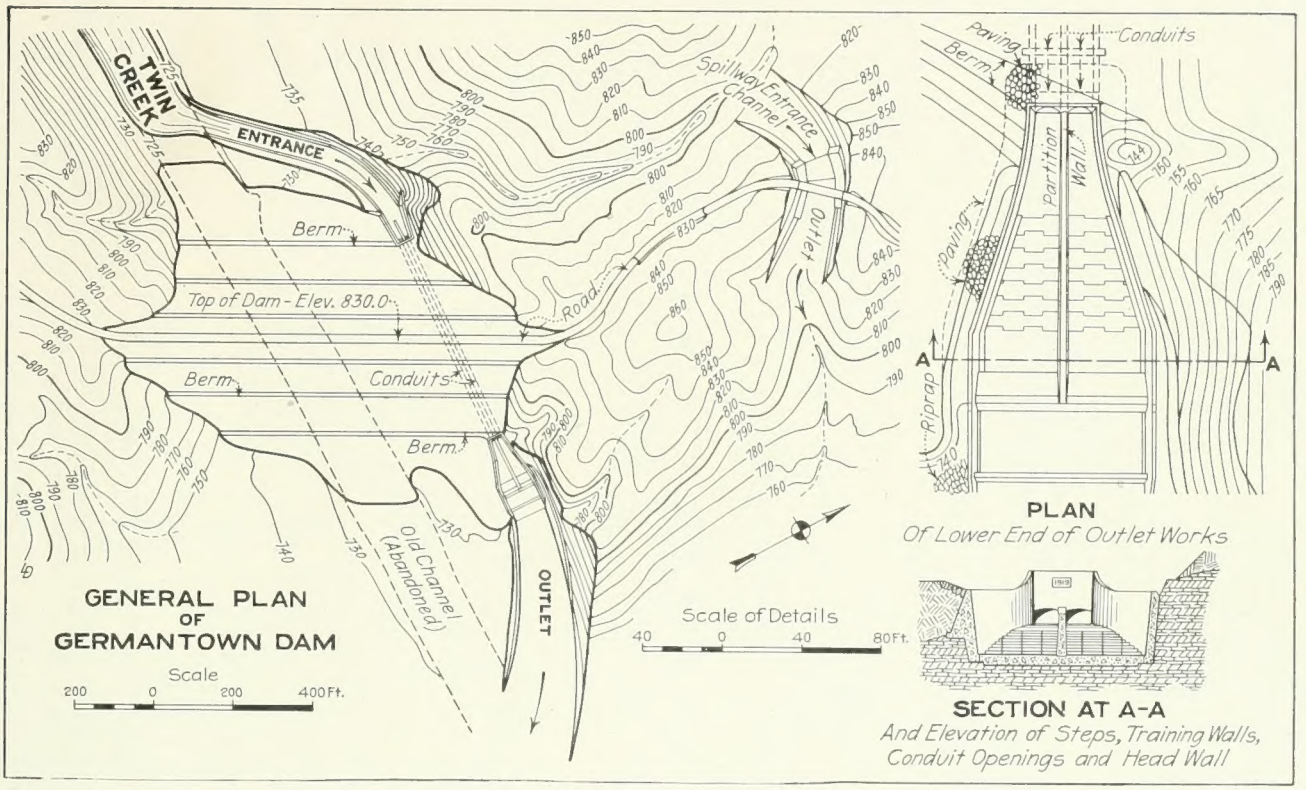


FIG. 244—PLAN OF GERMANTOWN DAM AND PLAN AND SECTION OF OUTLET WORKS.

stream toe. This excavation was by hydraulic monitor, the material being sluiced down the hillslope by gravity directly into the sump. The addition of this material cured the difficulty as to fines in the fill, and added to the quantity of material placed in the dam without any addition to the cost of pumping, the added fines acting as a "grease" to the interior dredge pipe surfaces, reducing the friction loss due to the sharp particles of sand and gravel. Incidentally this reduced friction also reduced wear on the pipes.

The rate of pumping rapidly increased as the equipment was adjusted to the conditions encountered, the quantity placed being 35,000 cubic yards in July, 50,600 in August, 58,200 in September, and 91,500 in October. It dropped again, unavoidably, with the advent of colder weather, and early in February, 1920, was stopped while the equipment was put in shape for the spring's resumption of work. The embankment placed up to that time was 412,400 cubic yards, approximately 52 per cent of the total requirement. The elevation reached was that of the second berm, 60 feet above the river bed, and 50 feet below the top of the dam. This carried it to a level sufficient to hold a flood equal to that of 1913, this mark having been set to provide ample insurance against a possible flood overtopping the unfinished embankment.

Among the devices which proved efficacious in speeding up the rate of pumping of the materials, as noted, were the substitution of manganese steel dredge pump runners for cast iron, eliminating breakages; the enlarging of the runner shoe, increasing thereby the pump capacity; the introduction of a revolving screen to eliminate the oversize rock at the hogbox; and the hydraulicking of the hillside material already mentioned, increasing the solids pumped without increasing the pumping cost.

Early in the pumping, in August, 1919, the old bed of the river had been cleaned of all mud and silt and rubbish, and a clay blanket spread over it, following which the embankment was extended across the entire width of the valley, effecting closure. It should also be noted that the materials were deposited on the upstream and downstream sides of the embankment alternately, the levees being carried up at the slope summits by the small caterpillar dragline casting up material from the pool beaches. This procedure saved time out for shifting pipe line crew and dragline excavator back and forth across the pool and beaches.

During the winter shutdown, besides the refluing of the dinkies, and repairs to the dragline excavators, the hogbox, etc., a booster pump was installed on the second berm of the dam, 50 feet below the summit, to help lift the remaining material into place.

Pumping was resumed on March 22, 1920. About the same time the surfacing of the dam slopes was started. On the upstream slope, up to the second berm, the surfacing was of oversize rock from the nearby hogbox, a considerable stock having accumulated, and this being an economical disposition to make of it while providing a good finishing material for the embankment. On the downstream slope, up to the same level, the surfacing material is top soil from the damsite stripping, reserved for the purpose. The best surface treatment to provide for the upper levels remaining is a matter still under consideration.

On April 20 the first real test of the dam was encountered in the shape of a flood which rose at the

conduit entrance to within a foot of the top of the head wall. Special interest centered in the conduit outlet works, designed to create a hydraulic jump as an absorbent for the destructive energy of the issuing water. The design, embodying the solution of one of the most important and difficult problems which the Conservancy engineers had to face, operated in a thoroughly satisfactory manner, quite up to what had been expected of it. A decided jump was developed, about seven feet in height. The flood did only a small amount of damage to the plant, although the lower pumping plant was submerged for a number of hours. The pumping was shut down for only five days.

From this time the work of placing the earth materials in the dam embankment went steadily forward with only minor delays. In March (beginning on the 22nd), 29,600 cubic yards were placed; in April, 57,150; in May, 63,580; in June, 44,000; in July, 62,670; in August, 31,680 (made up of 8 days' pumping from dragline excavation and 17 days from the hillside sluicing alone). This carried the dam to the third berm, 90 feet above the old river bed and only 20 feet from the top, and made it 90 per cent complete, with a total earth placed amounting to 701,420 cubic yards.

It was just above this point, at about 15 feet below the dam summit, that the changed procedure in the work of the hydraulic fill was made, described elsewhere in this issue (see page 71), the deposition of a distinct core being abandoned as no longer necessary. The hydraulic method was still used, but the earth materials were mixed, fine and coarse together, in the dam embankment, producing what has been called "mud concrete." (Not implying, however, any analogous hardening). Using this modified procedure, in September, 49,770 cubic yards of material were built into the dam; and in October and the first six days in November, 44,724 cubic yards, carrying the embankment to completion on November 6, with a total of 797,907 cubic yards of earth material placed.

The spillway (see page 73) was begun in June of 1919, excavation being started on that date, and continued as fietted with the exigencies of other work, till its completion in August, 1920, the total quantity being 18,300 cubic yards. The concreting plant was erected during July, 1920, and the excavation for bridge piers begun. Placing the concrete was started early in August, and the pouring of piers 2, 3, 4 and 5 completed by the end of the month. The slope revetments, cut-off trenches and wiers were finished during September; and the remainder of the work, both on the spillway and spillway bridge, were completed during October, including removal of falsework and trimming and finishing of the concrete. Evidence of the remarkable adaptation of the spillway site to its purpose is seen in the fact that the total concrete in both bridge and spillway was only 952 cubic yards.

The bringing of the outlet conduits to their final form, which was the next stage in the work, is described elsewhere in these columns. It will be finished during the present month (December, 1920). There will then remain only the dismantling of the construction plant, the disposition of the camp, and the final trimming and cleaning up.

Under the surveillance of the Conservancy physician, Dr. W. M. Smalley, the health of the camp was maintained at a high level throughout the work. The influenza epidemic was kept under control, with no deaths resulting. There was one death on the work from pneumonia, and two from accident. No doubt the excellent water and sewerage systems installed at the camp had much to do with the high health level.

FIG. 245—THE DOWNSTREAM SLOPE OF THE GERMANTOWN DAM

The view shows especially the flat sand and gravel slopes of the dam embankment, these growing flatter at each "berm" (or horizontal shelf), to give the dam a broad base, and ample stability. The upstream slope is similar.